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Mechanical Shock (Specified Pulse) Test Procedure for Electrical Connectors

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(Revision of EIA-364-27A)

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ELECTRONIC INDUSTRIES ASSOCIATION

ENGINEERING DEPARTMENT

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ELECTRONIC INDUSTRIES ASSOCIATION

TEST PROCEDURE No. 27B

MECHANICAL SHOCK (SPECIFIED PULSE) TEST PROCEDURE FOR ELECTRICAL CONNECTORS

This EIA Recommended Standard is based upon the technical content of International Electrotechnical Commission, Recommendation -512-4, Test 6c, Shock, 1976. It conforms in all essential respects with the IEC Recommendation.

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(From EIA Standards Proposal No. 3411, formulated under the cognizance of EIA CE-2.0 National Connector Standards Committee)

(This test procedure was previously published in EIA Recommended Standard RS-364 as TP-27A).

1 Object

The object of this test procedure is to detail a standard method to assess the ability of electrical components to withstand specified severities of mechanical shock.

2 General

This test is conducted for the purpose of determining the suitability of connectors and connector assemblies when subjected to shocks such as those that may be expected as a result of rough handling, transportation and operational conditions., This test differs from other shock tests in that the design of the shock machine is not specified, but the half-sine and sawtooth shock pulse waveforms are specified with tolerances. The frequency response of the measuring systems is also specified with tolerances.

3 Definitions

The following mounting axis definitions shall be employed during the performance of this test, unless otherwise specified in the Detail Specification.

3.1 Axis

Figure 1 indicates a pictorial view of the axis definitions. The Detail Specification shall indicate the fixturing required or the axis definitions if different than as stated in figure 1. Axis definitions for symmetrical, square and “free” connectors shall be defined in the Detail Specification.

3.1.1 X-axis
Along the longitudinal length of the test sample.

3.2.2 Y-axis
The axis perpendicular to the longitudinal length of the sample (transverse direction).

3.3.3 Z-axis
The axis perpendicular to the fixture seating plane attached to the test table.

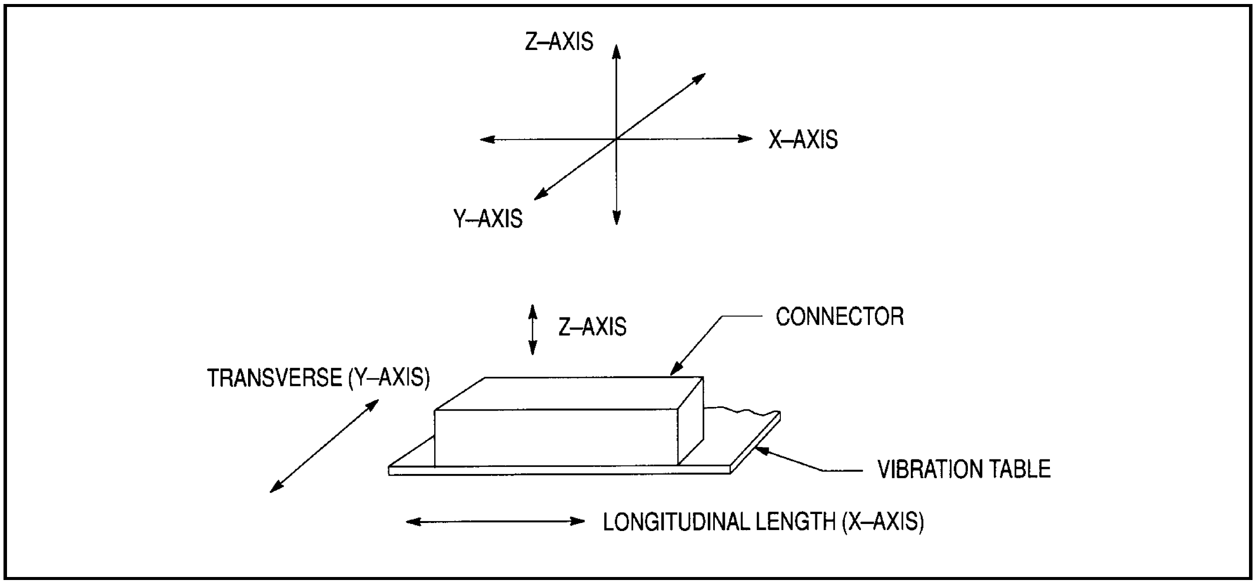


Figure 1- Mounting axis definitions

4 Preparation of the test sample

4.1 Unless otherwise specified, the test sample shall be fully wired and mated.

4.2 The test sample shall be mounted as specified in the connector Specification. If the test specimen is normally mounted on vibration isolator, the isolators shall be functional during the test. Whenever possible, the test load shall be distributed uniformly on the test platform in order to minimize the effects of unbalanced loads.

5 Test method

5.1 Test Equipment

5.1.1 Shock machine

The shock machine utilized shall be capable of producing the specified input shock pulse as shown in figure 2 or 3, as applicable. The shock machine may be of the free fall, resilient rebound, nonresilient, hydraulic, compressed gas, or other activating types.

5.1.1.1 Shock machine calibration

The actual test item, or a dummy load that may be either a rejected item or a rigid dummy mass, may be used to calibrate the shock machine. (When a rigid dummy mass is used, it shall have the same center of gravity and the same mass as that of the test item and shall be installed in a manner similar to that intended for the test item.) The shock machine shall then be calibrated for conformance with the specified waveform. Two consecutive shock applications to the calibration load shall produce waveforms that fall within the tolerance envelope given in figure 2 or 3. The calibration load shall then be removed and the shock test performed on the actual test item. If all conditions remain the same, other than the substitution of the test item for the calibration load, the calibration shall then be considered to have met the requirements of the waveform.

NOTE - It is not implied that the waveform generated by the shock machine will be the same when the actual test item is used instead of the calibration load. However, the resulting waveform is considered satisfactory if the waveform with the calibration load was satisfactory.

5.1.2. Instrumentation

The monitoring transducer shall be calibrated against a standard transducer having an accuracy of $\pm$2%. In order to meet the tolerance requirements of the test procedure, the instrumentation used to measure the input shock shall have the characteristics specified in the following.

5.1.2.1 Frequency response

The frequency response of the complete measuring system, including the transducer through the readout instrument, shall be as specified in figure 4.

5.1.2.1.1. Frequency response measurement of the complete instrumentation

The transducer-amplifier-recording system can be calibrated by subjecting the transducer to sinusoidal vibrations of known frequencies and amplitudes for the required ranges so that the overall sensitivity curve can be obtained. The sensitivity curve, normalized to be equal to unity at 100 Hz, shall then fall within the limits given in figure 4.

5.1.2.1.2. Frequency response measurement of auxiliary equipment

If the calibration factors given for the accelerometer are such that when used with the associated equipment it will not affect the overall frequency response, then the frequency response of only the amplifier-recording system may be determined. This shall be determined in the following manner:

Disconnect the accelerometer from the input terminals of its amplifier. Connect a signal voltage source to these terminals. The impedance of the signal voltage source as seen by the amplifier shall be made the same as the impedance of the accelerometer and associated circuitry as seen by the amplifier. With the frequency of the signal voltage set at 100 Hz, adjust the magnitude of the voltage to be equal to the product of the accelerometer sensitivity and the acceleration magnitude expected during test conditions. Adjust the system gain to a convenient value. Maintain a constant input voltage and sweep the input frequency over the range from 1.0 to 9,000 Hz, or 4 to 25,000 Hz, as applicable, depending on duration of pulse. The frequency response in terms of dB shall be within the limits given in figure 4.

5.1.2.2 Transducer

The fundamental resonant frequency of the accelerometer shall be greater than 30,000 Hz, when the accelerometer is employed as the shock sensor.

5.1.2.3 Transducer calibration

The accuracy of the calibration method shall be maintained within a tolerance of at least ±5% over the frequency range of 2 Hz to 5,000 Hz. The amplitude of the transducer being calibrated shall be held to the same tolerance (±5%) over the frequency range of 4 Hz to 5,000 Hz.

5.1.2.4 Transducer mounting

When conformance to 5.1.3 is required, the monitoring transducer shall be rigidly secured and located as near as possible to an attachment point of the specimen, but not on the specimen itself.

5.1.2.5 Linearity

The signal level of the system shall be chosen so that the acceleration pulse operates over the linear portion of the system.

5.1.3 Application of shock measuring instrumentation

Shock measuring instrumentation shall be utilized to determine whether the correct input shock pulse is applied to the test specimen. This is particularly important where a multispecimen test is made. Generally, the shock pulse shall be monitored whenever there is a change in the test setup, such as a different test fixture, different component (change in physical characteristics), different weight, different shock pulse (change in pulse shape, intensity, or duration) or different shock machine characteristics. It is not mandatory that each individual shock be monitored, provided that the repeatability of the shock application as specified in 5.1.1.1 has been established.

5.1.4 Shock pulses

Two types of shock pulses, a half-sine shock pulse, and a sawtooth shock pulse, are specified. The pulse shape and tolerances are shown in figures 2 and 3, respectively. For single degree of freedom systems, a sawtooth shock pulse can be assumed to have a damage potential at least as great as that of a half-sine pulse if the shock spectrum of the sawtooth pulse is everywhere at least as great as that of the half-sine pulse. This condition will exist for two such pulses of the same duration, if over most of the spectrum the acceleration peak value of the sawtooth pulse is 1.4 times the acceleration peak value of the half-sine pulse.

5.1.4.1 Half-sine shock pulse

The half-sine shock pulse shall be as indicated in figure 2. The velocity change of the pulse shall be within ±10% of the velocity change of the desired shock pulse. The velocity change may be determined either by direct measurement, indirectly, or by integrating (graphically or electrically) the area (faired acceleration pulse may be used for the graphical representation) under the measured acceleration pulse. For half-sine acceleration pulses of less than 3 milliseconds duration, the following tolerances shall apply:

The faired maximum value of the measured pulse shall be within ±20% of the specified ideal pulse amplitude, its duration shall be within ±15% of the specified ideal pulse duration, and the velocity change associated with the measured pulse shall be within ±10% of $V_i = 2AD/B$; where A is the acceleration amplitude and D is the pulse duration of the ideal pulse; see figure 2 .

5.1.4.1 Half-sine shock pulse (continued)

The measured pulse will then be considered a nominal half-sine pulse with a nominal amplitude and duration equal to respective values of the corresponding ideal half-sine pulse. The duration of the measured pulse shall be taken as D_m = D(0.1A)/0.94; where D(0.1A) is the time between points at 0.1A for the faired measured acceleration pulse.

5.1.4.2 The ideal half-sine pulse

An ideal half-sine acceleration pulse is given by the solid curve; see figure 2. The measured acceleration pulse shall lie within the boundaries given by the broken lines. In addition, the actual velocity change of the shock shall be within 10% of the ideal velocity change. The actual velocity change can be determined by direct measurements, or from the area under the measured acceleration curve. The ideal velocity change is equal to $V_i = 2AD/B$.

5.1.4.3 Sawtooth shock pulse

The sawtooth pulse shall be as indicated in figure 3. The velocity change of the faired measured pulse shall be within ±10% of the velocity change of the ideal pulse.

5.1.4.4 The ideal terminal peak sawtooth

An ideal terminal peak sawtooth acceleration pulse is given by the solid line; see figure 3. The measured acceleration pulse shall be within the boundaries given by the broken lines. In addition, the actual velocity change of the shock pulse shall be within 10% of the ideal value. The actual velocity change can be determined from direct measurements, or from the area under the measured acceleration curve. The ideal velocity change is equal to $V_i = PD/2$, where P is the peak value of acceleration, and D is the pulse duration.

5.2 Test procedure

Three shocks in each direction shall be applied along the three mutually perpendicular axes of the test specimen (18 shocks). The specified test pulse (half-sine or sawtooth pulse) shall be in accordance with figure 2 or 3, respectively, and shall have a duration and peak value in accordance with one of the test conditions shown in table 1.

Table 1 - Test condition value

Test condition	Peak acceleration		Normal duration (D) (ms)	Velocity change (V_i) (m/s : ft/s)	
	(m/s^2)	(g's)		Sawtooth	Half-Sine
H	294	30	11		2.07 : 6.8
I	294	30	11	1.62 : 5.3	
A	490	50	11		3.44 : 11.3
E	490	50	11	2.68 : 8.8	
B	735	75	6		2.81 : 9.2
F	735	75	6	2.20 : 7.2	
C	980	100	6		3.75 : 12.3
G	980	100	6	2.96 : 9.7	
D	2941	300	3		5.61 : 18.4
J	4903	500	1		3.11 : 10.2
K	9806	1000	0.5		3.11 : 10.2
L	14709	1500	0.5		4.69 : 15.4

NOTE - For test conditions D, J, K and L, where the weight of multi-specimen and fixtures exceeds 68 kg (150 lb), there is a question as to whether the shock pulse is properly transmitted to all specimens. Due consideration shall be given to the design of the test fixture to assure the proper shock input to each specimen.

5.3 Measurements

Measurements are to be made on mated connectors before and after the required number of shocks unless otherwise specified, and during the test, if specified.

5.3.1 Unless otherwise specified in the Detail Specification, the electrical load conditions shall be 100 milliamperes maximum for all contacts.

5.3.2 Unless otherwise specified in the Detail Specification, no discontinuities of one microsecond or greater duration are allowed. A detector capable of detecting the specified discontinuity shall be used.

6 Details to be specified

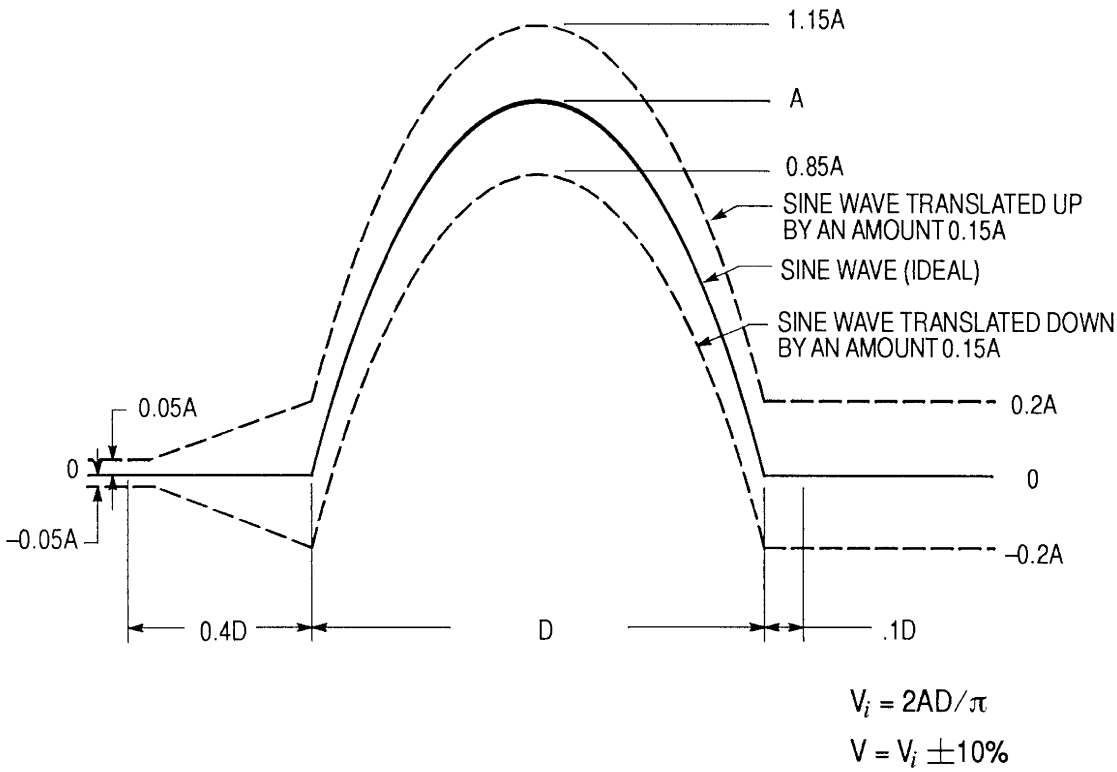
The following details shall be specified in the Detail Specification:

6.1 Mounting method and accessories, location of wire clamps (see 4.2).
6.2 Test specimens (mated unless otherwise specified).
6.3 Test condition letter (see table 1).
6.4 Electrical load conditions (see 5.3).
6.5 Event requirement if other than 1 microsecond.
6.6 Measurement of discontinuity during shocks (see 5.3).
6.7 Tests or measurements before and after shocks (see 5.3).
6.8 Monitoring instrumentation, if applicable (see 5.1.3).
6.9 Location of monitoring transducers, if applicable (see 5.1.2.4).
6.10 Mounting axis (see clause 3).

7 Documentation

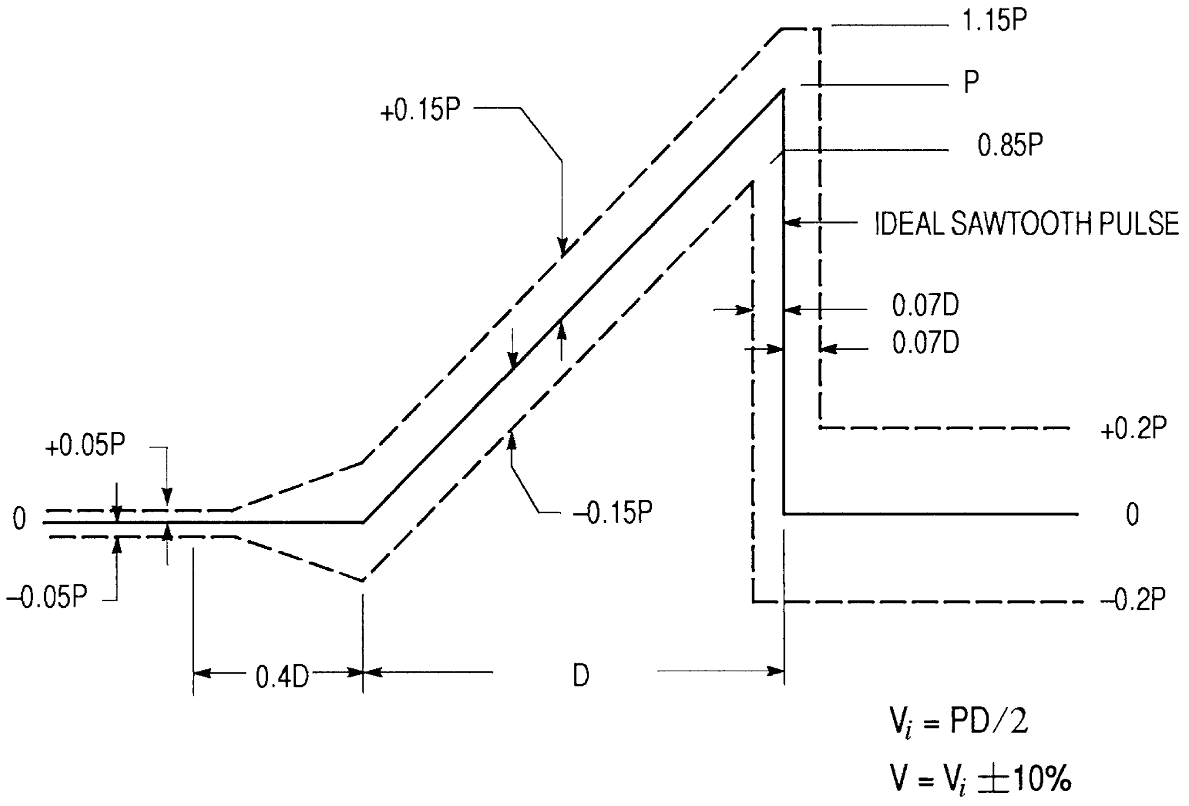
The data sheets should contain:

7.1 Title of test.
7.2 Sample description - include fixture, if applicable.
7.3 Test equipment used, date of latest calibration and calibration interval.
7.4 Test condition letter.
7.5 Photographs, plots, values and observations necessary for proof of conformance.
7.6 Mounting axis (see clause 3)
7.7 Date of test and name of operator.



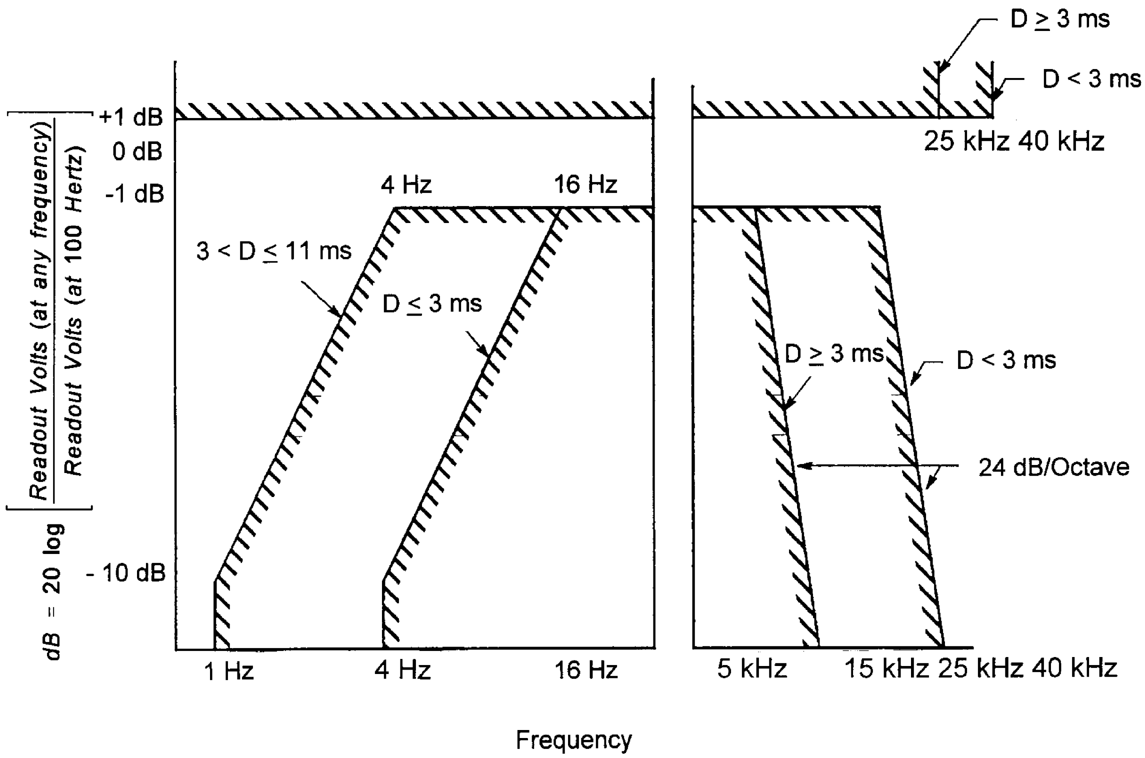
NOTE - The oscillogram should include a time about 3D long with the pulse located approximately in the center. The integration to determine velocity change should extend from 0.4D before the pulse to 0.1D beyond the pulse. The acceleration amplitude of the ideal half since pulse is A and its duration is D. Any measured acceleration pulse that can be contained between the broken line boundaries is a nominal half sine pulse of nominal amplitude A and nominal duration D. The velocity-change associated with the measured acceleration pulse is V.

Figure 2 - Tolerances for half-sine shock pulse



NOTE - The oscillogram should include a time about 3D long with the pulse approximately in the center. The integration to determine the velocity change should extend from 0.4D before the pulse to 0.1D beyond the pulse. The peak acceleration magnitude of the sawtooth pulse is P and its duration is D. Any measured acceleration pulse that can be contained between the broken line boundaries is a nominal terminal-peak sawtooth pulse of nominal peak value, P, and nominal duration, D. The velocity-change associated with the measured acceleration pulse is V.

Figure 3 - Tolerances for terminal peak sawtooth shock pulse



Duration of pulse (ms)	Low-frequency cut-off (Hz)		High-frequency cut-off (kHz) -1 dB	Frequency beyond which the response may rise above +1 dB (kHz)
	-1 dB	-10 dB		
<3	16	4	15	40
3	16	4	5	25
>3	4	1	5	25

Figure 4 - Tolerance limits for measuring system frequency response